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NIMBUS 7 Coastal Zone Color Scanner (CZCS)

Level 1 Data Product Users' Guide

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NIMBUS-7
COASTAL ZONE COLOR SCANNER
(CZCS)

Level-1 Data Product User's Guide

1 THE COASTAL ZONE COLOR SCANNER EXPERIMENT

1 1 Introduction

The Nimbus-7 spacecraft was launched in October 1978, and has been producing data for over five years The Coastal Zone Color Scanner (CZCS), flying on Nimbus-7, is a multispectral line scanner devoted principally to measurements of ocean color It has six spectral bands (channels), four chiefly for ocean color, each of 20 nanometer band width and centered at 443, 520, 550, and 670 nanometers These are referred to as channels 1 through 4, respectively Channel 5 senses reflected solar radiance, but has a 100 nanometer band width centered at 750 nanometers and a dynamic range which is more suited to land Channel 6 operates in the 10 5 to 12 5 micrometer region and senses emitted thermal radiance for derivation of equivalent black body temperature

The CZCS scans a swath width of approximately 1600 kilometers with a spatial resolution at the nadir of 800 meters in each of the 6 co-registered channels Data acquired from the CZCS are processed at the Goddard Space Flight Center into two product levels Level-1 products contain earth located raw radiance counts and calibration information Level-2 products contain derived information such as pigment concentrations, aerosol radiances, subsurface radiances, and diffuse attenuation coefficients which are obtained from the raw data using scientific processing algorithms developed by members of the CZCS Nimbus Experiment Team (NET) Digital tape and film products are produced and archived for both of the product levels

The guide is intended for users of Nimbus-7 CZCS Level-1 data products The CZCS instrument and theoretical foundations behind the experiment are described in Section 1 Sec-

tion 2, contains a brief description of the image location and calibration algorithms implemented for production of Level-1 products The CZCS Level-1 tape format is described in Section 3 Finally, Section 4 contains information on data availability and costs

1 2 Theoretical Foundations and Objectives

The CZCS is intended primarily as a tool for determining the content of water It is well known that the content of water, be it organic or inorganic particulate matter or dissolved substaces, affects its color Ocean water, containing very little particulate matter, scatters as a Rayleigh scatterer with the well known deep purple or bluish color of the ocean As particulate matter is added to the water, the scattering characteristics are changed and the color is changed Phytoplankton, for instance, have specific absorption characteristics and normally change the water to a more greenish hue although some phytoplankton, such as the various red tide, can change the water to colors such as red, yellow, blue-green, or mahogany By sensing the color with very high signal-to-noise ratios, the CZCS provides a mechanism for analyzing that color for the content of the water Inorganic particulate matter in water, such as the terrigenous outflow from rivers, has a different color from organic material typically brownish in color but sometimes varying with red

1 2 1 Scientific Objectives

The scientific objective of the CZCS is to determine the specific nature of the contents of water as quantitatively as possible and to carry out such measurements over large areas in short periods of time in a way not possible with other techniques such as surface ship investigations Specifically, the CZCS experiment attempts to discriminate between organic and inorganic materials in the water, determine the quantity of these materials in the water sample to the best degree possible and, in certain instances, attempts identification of organic particulates such as discriminating between various types of red tide organisms

By conducting measurements over a large area in a short period of time, the CZCS allows oceanographers to view the ocean as never seen before from ships As an example, in one two-

minute data segment, the CZCS covers approximately 1 3 million square kilometers of the ocean surface allowing examination, nearly simultaneously, on a scale never before accomplished Measurements on this scale allow oceanographers to determine such things as the standing stock of phytoplankton and its distribution in various fishing areas and, potentially, to assess the ability of that area to support a standing stock of fish In addition to examining the existing fisheries, the CZCS will be used to look for new areas of potential fish production around the globe

1 2 2 Technical Objectives

The technical objective of the CZCS program is to determine if remote sensing of color can be used to identify and quantify material suspended or dissolved in water If ocean color measurements can be used to derive such products as chlorophyll and sediment concentration, they will guide further development of the ocean color discipline and help to determine if such an instrument is a candidate for operational satellite use in the future

The algorithms being developed for the derived products from CZCS are the result of the most extensive ocean color measurements ever made and are a considerable step forward from those available in the past Corrections for such things as atmospheric backscatter and limb brightening are included in the CZCS processing algorithms The processing goal is to take the observed radiance, determine the radiance that would be seen directly above the ocean surface, and then derive from that radiance, the content of the water below the ocean surface

1 3 Instrument Description

The CZCS has considerable flexibility built into it to accomodate a wide range of conditions The first four spectral bands, for instance, have four separate gains that change, on command, to accommodate the range of sun angles observed during a complete orbit and throughout the various seasons The gains are changed to utilize the best dynamic range possible without saturating over water targets Normally, the gain used in the first four channels is determined by the solar elevation angle of the target to be acquired When a special circum-

stance is expected, such as a particularly bright material in the water, the gain can be changed to accommodate the special circumstances

In addition to gain change, the CZCS scan mirror can be tilted from nadir to look either forward or behind the spacecraft's line of flight It can tilt in two degree increments up to twenty degrees in either direction This feature was built into the instrument to avoid the glint caused by capillary waves on the ocean that would obscure any scattering from below the surface The angle of tilt of the scan mirror is determined by the solar elevation angle It is normally tilted to avoid sunlight and would only be commanded to look into the glint for a special sunglint study

The CZCS is a scanning multi-spectral radiometer with a recorded scan width of 1566 kilometers centered on spacecraft nadir The scanner actually scans through 360 degrees, but the electronics limit the high data rate sampling to 39 34 degrees about nadir The ground resolution of the IFOV is 0 825 kilometer at nadir and degrades somewhat as the instrument scans away from nadir on either side

The CZCS has six spectral bands, five sensing backscattered solar radiance and one sensing emitted thermal radiance The beam is split by a dichroic beam splitter, one portion of the beam going through a set of depolarizing wedges to a small polychromator where the radiance is dispersed and detected by five silicon diode detectors in the focal plane of the polychromator Radiance in the 10 5 μm to 12 5 μm spectral band is reflected off the dichroic and then imaged onto an infrared detector of mercury cadmium telluride cooled to approximately 120 Kelvin Table 1-1 shows the center wavelengths, the spectral bandwidths, and the minimum signal-to-noise ratio specified for the instrument at the most sensitive gain setting, that is, the gain setting that would be used for the darkest targets. The first four channels were selected to cover specific absorption bands and the so-called hinge point These channels are meant to look at water only and saturate when the field of view is over most land surfaces and clouds

Table 1-1
CZCS Performance Parameters

Performance Parameters	Channels					
	1	2	3	4	5	6
Scientific Observation	Chlorophyll Absorption	Chlorophyll Correlation	Yellow Stuff	Chlorophyll Absorption	Surface Vegetation	Surface Temperature
Center Wavelength λ Micrometers	0.443 (blue)	0.520 (green)	0.550 (yellow)	0.670 (red)	0.750 (far red)	11.5 (infrared)
Spectral Bandwidth Δλ Micrometers	0.433 – 0.453	0.510 – 0.530	0.540 – 0.560	0.660 – 0.680	0.700 – 0.800	10.5 – 12.5
Instantaneous Field of View (IFOV)	← 0 865 x 0 865 Milliradians (0.825 x 0.825 km at sea level) →					
Co-registration at NADIR	<0.15 Milliradians					
Accuracy of Viewing Position Information at NADIR	<2.0 Milliradians					
Signal to Noise Ratio (min.) at Radiance Input N < (mW/cm^2 · STER · μm)	>150 at 5.41	>140 at 3.50	>125 at 2.86	>100 at 1 34	>100 at 10 8	NETD of 0.220°K at 270°K
Consecutive Scan Overlap	25%					
Modulation Transfer Function (MTF)	1 at 150 km target size, 0 35 min. at 0 825 km target size					

Channel 5 has the same spectral response as channel 6 of the Landsat multi-spectral scanner series The spectral response of channels 1 through 5 is illustrated in Figure 1-1

The 10 5 μm to 12 5 μm channel measures equivalent blackbody temperature as seen by the sensor with a noise equivalent temperature difference of less than 0 35 Kelvin at 270 Kelvin Atmospheric interference with this channel, principally from weak water vapor absorption in the 10 5 μm to 12 5 μm region, can produce measurement errors of several degrees Temperature gradients, however, should be seen quite well because of the extremely low noise equivalent temperature difference of this sensor

Prelaunch calibration of the CZCS was achieved utilizing a 76 centimeter diameter integrating sphere as a source of diffuse radiance for channels 1 through 5 and a blackbody source for calibration of channel 6 The integrating sphere was especially constructed for calibration of the CZCS and was, itself, calibrated from a standard lamp from the National Bureau of Standards utilizing a spectrometer and another integrating sphere to transfer calibration from the lamp to the sphere

In addition to the sphere and the blackbody, a collimator was also used to calibrate the CZCS in vacuum testing Calibration was transferred from the primary calibration standard, the sphere and the blackbody, to the collimator using the instrument itself

In-flight calibration of the CZCS is accomplished for the first five bands by using a built-in incandescent light source This in-flight calibration source was calibrated using the instrument itself as a transfer against the referenced sphere output The light source is redundant in the instrument so that in case of failure of one of the lights, another one can be ordered to operate on command After launch, light calibration source number one has been used routinely, with light source number two tested occasionally to verify its stability

Channel 6 is calibrated by viewing the blackened housing of the instrument whose temperature is monitored Deep space is another calibration viewed during the 360 degrees rotation of the scan mirror

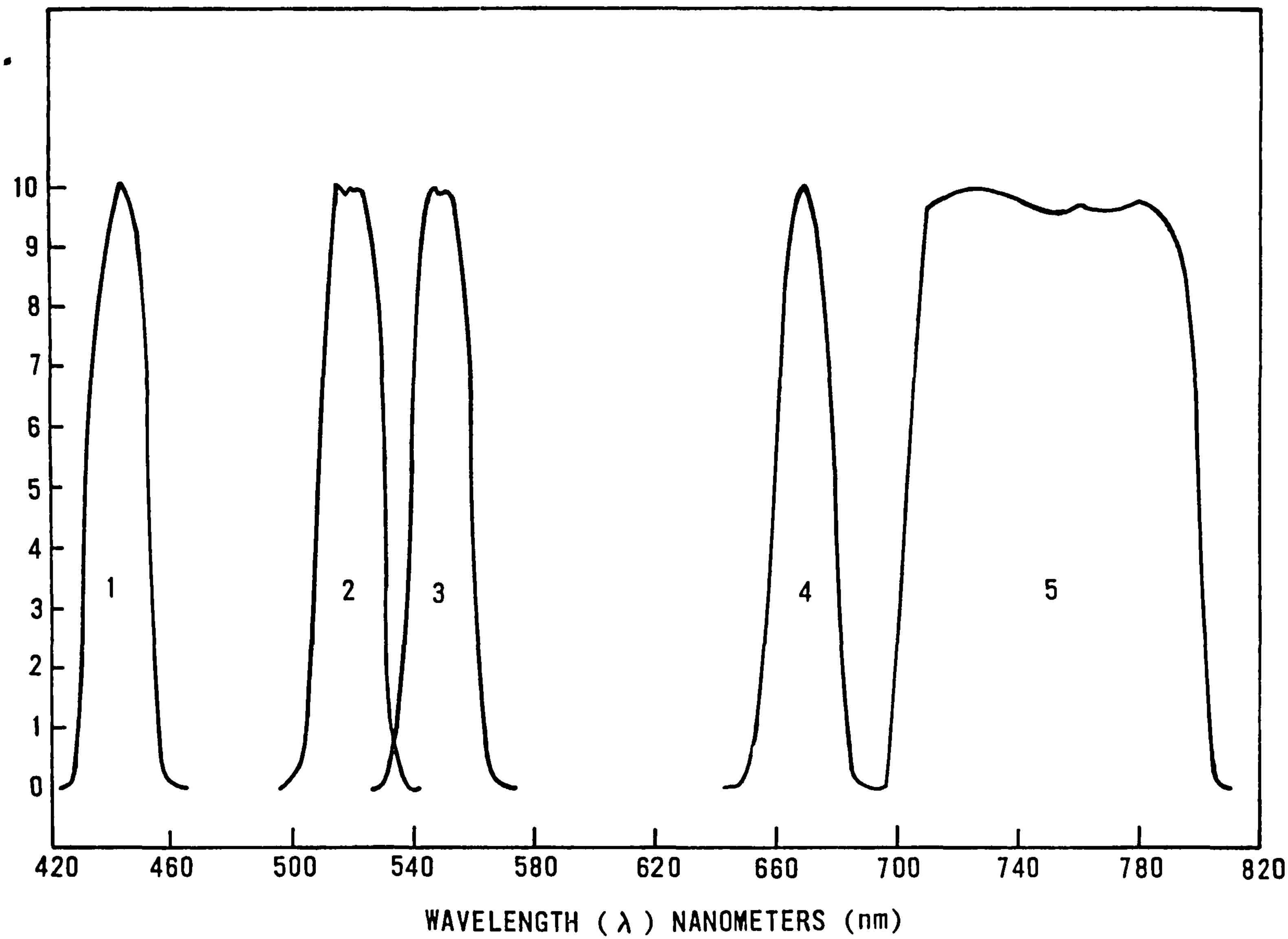

Figure 1-1 CZCS Spectral Response for Channels 1 through 5

Since Nimbus 7 flys from south to north in daylight, the scan mirror is positioned to look behind the satellite when the spacecraft is south of the subsolar point and ahead of the spacecraft when it is north of the subsolar point Tilt and gain setting information is transmitted with the CZCS data and is part of the data product records

The CZCS data is transmitted from the spacecraft to ground receiving stations at a rate of 800 kbs either in real time or in playback of the tape recorder Whenever possible the data is recorded in real time However, when the satellite is out of the range of tracking stations, the data is recorded on an on board tape recorder The tape recorded data will normally be played back at the Alaska tracking station Nine other STDN's also have the capability to receive these playbacks

The most important aspect to be understood about the CZCS operation is that the operation is limited due to spacecraft power constraints to approximately two hours per day Because of the requirement to operate the sensor two hours per day, data must be taken in carefully preselected locations Minimum on-off data taking time is a two minute segment Frequently, longer segments are taken—up to a maximum of ten minutes of continuous data

All channels of the CZCS instrument operate simultaneously During daytime operations all six channels provide useful information If the sensor operates at night, only data from channel 6 is usable

2 0 CZCS LEVEL-1 PROCESSING ALGORITHMS

2 1 Data Calibration

2 1 1 Active Calibration

The objective of the Level-1 processing system calibration algorithm is to derive the coefficients necessary to convert the raw 8-bit digital count values transmitted by the satellite, into observed radiance values in units of micro watts per square centimeter micrometer steradians

The 8-bit digital data output from the satellite is functionally related to the radiance reaching the individual channel detectors by

$$\underset{(R)}{\text{RADIANCE}} \rightarrow \boxed{\text{DETECTOR}} \rightarrow \underset{(V)}{\text{VOLTAGE}} \rightarrow \boxed{\begin{array}{c}\text{A-D}\\ \text{CONVERTER}\end{array}} \rightarrow \underset{(C)}{\text{COUNTS}}$$

$$V = a_s * R \qquad\qquad C = a_c V + b_c$$

where a_s, a_c, and b_c are coefficients which must be derived from the prelaunch calibrations and/or the active calibration data sources

The A-D converter coefficients a_c and b_c are computed once per scene using a voltage staircase which is generated by feeding 16 known voltages (zero to 9 960 in increments of 0 664 volts) into the A-D converter Values of a_c and b_c are derived by fitting a straight line equation to the staircase data by the method of least squares such that

$$a_c = \frac{\Sigma V^*C - \dfrac{\Sigma V^*C}{n}}{\Sigma V^2 - \dfrac{(\Sigma V)^2}{n}} \tag{1}$$

$$b_c = \frac{\Sigma C - a_c \Sigma V}{n} \tag{2}$$

where counts of zero and 255 are ignored

Once the A-D converter coefficients are known, the detector coefficient (a_s) can be determined from the count value which is returned when the detector is exposed to one of the two internal known radiance lamps The detector coefficient for each visible channel is derived once per scene using

$$a_s = \frac{\dfrac{C_a - b_c}{a_c}}{\dfrac{C_a}{C_x} R} \tag{3}$$

where C_a is the active calibration lamp count for the first calibration lamp exposure within the scene, R is the known lamp radiance in each visible channel (see table 2-1), and C_x is the prelaunch calibration lamp count (see table 2-2) Active calibration of the thermal channel (6) is performed using equation 3 by replacing C_a with the count obtained when the internal black-body target is viewed and replacing R with the radiance derived from monitoring the temperature of the blackbody target

Once the detector coefficient has been derived, the instrument calibration coefficients (combined A-D converter and detector coefficients) A_R' and B_R' are derived using

$$A_R' = \frac{1}{a_s\ a_c} \quad (4) \qquad B_R' = \frac{-b_c}{a_s\ a_c} \quad (5)$$

These values are placed on the trailing documentation record of the CRT tape and may be utilized to convert counts, as contained on the CRT, to radiance units by

$$R = C\ A_R' + B_R'$$

where the radiance units computed are MW/CM^2 Micrometers Ster

WARNING THE CZCS NET DOES NOT RECOMMEND THE USE OF THESE COEFFICIENTS PRELAUNCH CALIBRATION COEFFICIENTS AS CONTAINED ON THE LEADING DOCUMENTATION RECORD ARE RECOMMENDED SEE SECTION 2 1 2 FOR IMPLEMENTATION PROCEDURE

In order to perform active calibration of the thermal channel (6) in terms of temperature, it is necessary to utilize the Planck Equation in its inverse form

$$T(R) = \frac{b}{\left(\frac{a}{\lambda^5\ R} + 1\right)} - 273\ 15 \quad (7)$$

where b is a constant = 1 438833 $*10^4$,

a is a constant = 1 61*11910 66

Table 2-1 Prelaunch Calıbratıon Lamp Radıances

Channel	Lamp 1	Lamp 2
1	2 04	2 55
2	1 55	1 72
3	1 37	1 52
4	1 11	1 13
5	5 24	5 15

Table 2-2 Prelaunch Calıbratıon Lamp Count

Lamp 1 GAIN

Channel	1	2	3	4
1	045	054	067	095
2	048	059	072	102
3	051	066	079	110
4	096	120	146	206
5	056	056	056	056

Lamp 2 GAIN

Channel	1	2	3	4
1	056	070	085	118
2	053	065	079	112
3	058	073	089	124
4	099	121	145	204
5	055	055	055	055

λ is the wavelength of channel 6 = 11 485,

R is the equation 6 radiance $*10^{-3}$ and,

T(R) is the temperature in °C

For user convenience, a table of 256 temperature values is placed on the CRT tape trailing documentation record (see Section 3) The user should note that the temperature conversion table is not corrected for atmospheric absorption

WARNING CHANNEL 6 DATA COLLECTED AFTER ORBIT 5056 SHOULD BE CONSIDERED SUSPECT

2 1 2 Post Launch Corrections

As stated previously, the CZCS NET does not recommend the use of calibration coefficients as derived from the active calibration sources The active calibration sources have been shown to fluctuate by one to two digital counts resulting in random banding when applied to the CZCS data For this reason, the CZCS NET recommends using the prelaunch calibration coefficients (see table 2-3) with a surface truth based correction for instrument degradation This procedure may be implemented by

$$R = (AR*C + BR)*F \tag{8}$$

where AR and BR are defined in table 2-3 and on the CRT tape leading documentation record, C is the raw digital count value as contained on the CRT tape, and F is the instrument degradation correction factor

The instrument degradation correction factor (F) may be derived by

$$F = d/(a + (b*N) + (c*N^2)) \tag{9}$$

where a, b, c and d are as defined in table 2-4 and N is the orbit number

The values listed in table 2-4 were derived by Dr Howard Gordon et al[1] and are generally

1 H R Gordon, J W Brown, O B Brown, R H Evans, and D K Clark, Appl Opt 22, 3929 (1983)

Table 2-3 Prelaunch Calibration Coefficients

	GAIN 1		GAIN 2	
Channel	AR	BR	AR	BR
1	04452	03963	03589	05276
2	03103	06361	02493	08826
3	02467	0799	02015	06247
4	01136	.01136	00897	03587

5-6 Use AR′ and BR′ as listed on trailing documentation record

	GAIN 3		GAIN 4	
Channel	AR	BR	AR	BR
1	02968	02879	02113	03359
2	02032	09752	01486	05647
3	01643	06570	01181	04723
4	00741	02963	00535	01604

5-6 Use AR′ and BR′ as listed on trailing documentation record

Table 2-4 Instrument Degradation Correction Coefficients

ALL GAINS

Channel	a	$-b*10^5$	$c \times 10^{10}$	d
1	1 069	2 32	5 00	1 069
2	1 024	0 59	0	0 993
3	1 007	0 28	0	0 955
4	1 000	0	0	1 000

thought to be valid through orbit 19,000 Research is continuing to develop improved coefficients which will extend to later orbits Any improvements will be published as an addendum to this guide

2 2 Image Location

The objective of the CZCS Level-1 processing system image location algorithm is to compute geodetic locations of 77 predefined picture elements (pixels), known as anchor points, on each scan line. The algorithm implemented for computation of earth locations closely follows the formulation described by Puccinelli[2]

The basic concept is to define a primary cartesian coordinate system with its origin at the center of the earth such that the earth's surface (approximated by a spheroid) is defined by

$$\frac{X^2 + Y^2}{a^2} + \frac{Z^2}{c^2} = 1 \qquad (10)$$

where a is the equatorial and c the polar radious of the earth The Nimbus Operational Processing System (NOPS) produces Image Location Tapes (ILT's) which provide spacecraft position, velocity, and attitude data as computed from world wide tracking data and the spacecraft epheremis For any given instant in time, the spacecraft position s, and velocity v relative to the primary coordinate system may be interpolated from data contained on the NOPS ILT Additionally, the spacecraft yaw, pitch, and roll may be computed relative to the satellite axis The satellite axis is defined relative to the primary coordinate system such that the roll axis is coincident with the velocity vector ($\vec{V}$), the pitch axis is defined as $\vec{v} \times \vec{s}$, and the yaw axis is $\vec{v} \times (\vec{v} \times \vec{s})$

Finally, the scanner orientation may be derived relative to the spacecraft This orientation, derived as a function of the pixel number (N) to be located and the scanner tilt angle, is defined by

$$\vec{W}_1 = 0 \qquad \text{(yaw)}$$

2 Puccinelli, Edward F , "Ground Location of Satellite Scanner Data", Photogrammetric Engineering and Remote Sensing, Vol 42, No 4, April 1976, pp 537-543

$$\vec{W}_2 = \text{TILT} \qquad \text{(pitch)}$$

$$\vec{W}_3 = \text{Scan Angle} \qquad \text{(roll)}$$

where the tilt and scan angle are adjusted from the recorded values for the internal misalignment of the mirror rotation axis and the tilt axis with the spacecraft y – axis (see table 2-5)

Given the spacecraft position (s), velocity (v), roll (R), pitch (P), yaw (Y) and the scanner orientation (w), the point of intersection (e) of the scanners line of sight with the earth is computed by first forming the vector m

$$\vec{m} = \begin{bmatrix} Cw_1 \cdot Sw_1 \cdot Cw_3 + Sw_1 \cdot Sw_3 \\ Sw_1 \cdot Sw_2 \cdot Cw_3 - Cw_1 \cdot Sw_3 \\ Cw_2 \cdot Cw_3 \end{bmatrix} \tag{11}$$

where S and C are notational conventions for Sin and Cos respectively Next, the product M is formed using the three spacecraft rotational matrics such that

$$M = \begin{bmatrix} CY & -SY & 0 \\ SY & CY & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} CP & 0 & SP \\ 0 & 1 & 0 \\ -SP & 0 & CP \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & CR & -SR \\ 0 & SR & CR \end{bmatrix} \tag{12}$$

Next, the unit vector, g, representing the scanner's line of sight in the primary coordinate system is defined as

$$g = DM\vec{m}$$

where $D = [\vec{C}_1, \vec{C}_2, \vec{C}_3]$ such that

$$\vec{C}_1 = \vec{v} / \|\vec{v}\|_2 \quad \text{(roll)} \tag{13}$$

$$\vec{C}_2 = (\vec{c}_1 \times \vec{s}) / \|\vec{s}\|_2 \quad \text{(pitch)} \tag{14}$$

$$\vec{C}_3 = (\vec{c}_1 \times \vec{c}_2) \quad \text{(yaw)} \tag{15}$$

Table 2-5

External Input Required For Image Location

Equatorial Radius of Earth	6378 144 KM
Polar Radius of Earth	6356 759 KM
Tilt Misalignment	$- 1\ 018109 \times 10^{-4}$ rad
Mirror Rotation Axis Misalignment	$1\ 599885 \times 10^{-4}$ rad
Pixel 1 Mirror rotation angle	6813765 rad

The intersection point given in the primary coordinate system is then defined as the vector e where

$$\vec{e} = \vec{s} + \vec{g} \left(\frac{-B \ -(B^2 - AC)^{1/2}}{A} \right) \tag{16}$$

where for equatorial radius (a) and polar radius (c)

$$A = C^2 (g_x{}^2 + g_y{}^2) + a^2 gz^2 \tag{17}$$

$$B = C^2 (S_x g_x + S_y g_y) + a^2 S_z g_z \tag{18}$$

$$C = C^2 (S^2{}_x + S^2{}_y) + a^2 (S^2{}_z - C^2) \tag{19}$$

Finally, the geodetic earth location is computed as

$$\text{latitude} = \tan^{-1} \frac{a^2}{c^2} \times \frac{e_3}{\sqrt{e_3{}^2 + e_2{}^2}} \tag{20}$$

$$\text{longitude} = \tan^{-1} \frac{e_2}{e_1} \tag{21}$$

These computations are performed for 17 of the 77 anchor points along each scan line Geodetic earth locations for the remaining 60 anchor points are computed by cubic spline interpolation between the 17 precisely located points Table 2-6 lists the CZCS anchor point pixel numbers and notes those anchor points which are precisely located

Table 2-6

Anchor Point Pixel Numbers

1*	216	556	1172	1627*	1877
16	236*	591	1217	1652	1892
31*	256	626	1262	1672	1907**
46	276	666*	1302**	1692	1922
61*	296	706	1342	1712	1937**
76	316	751	1377	1732**	1952
91	341*	796	1412	1752	1968*
106	366	841	1442	1772	
121	391	886	1472	1787	
136*	416	931	1502	1802	
151	441*	984*	1527**	1817	
166	466	1037	1552	1832**	
181	496	1082	1577	1847	
196	526	1127	1602	1862	

*Precise location computed at this pixel number

**Precise location computed at this pixel number +1

3 0 TAPE FORMATS

The CIPS program creates an output tape called the CRT tape This tape can be described in terms of its physical structure and/or its logical structures

3 1 Physical Structure of CRT Tape

The CRT tape is a multiple–file binary tape written in fixed block (FB) format on a MODCOMP machine It contains up to three file pairs each consisting of a header file and a data file

The first file, of each file pair, is a special file called the standard header or STD HDR The STD HDR file is written in a standard format common to all archivable tapes produced by the Nimbus Operational System (NOPS) and contains two identical blocks of 630 characters written in EBCDIC Each block consists of five 126-character lines

Lines 1 and 2 of the standard header records contain the following information

- Nimbus-7 NOPS tape product format specification number consisting of 30 characters written as ${}_b$NIMBUS-7$_b$NOPS$_b$SPEC$_b$NO$_b$T744041
- Tape sequence number consisting of a two character code identifying the tape, a six character sequence number unique to each tape, and a one digit number specifying the copy number An example for the CRT tape is ${}_b$SQ$_b$NO$_b$ZE2201213
- Subsystem identification code consisting of four-characters preceeded and followed by blanks For the CRT tape this is ${}_b$CZCS$_b$
- Generation and destination facilities consisting of four characters each An example is IPD$_{bb}$TO$_b$22$_{bb}$
- Beginning and ending times of data coverage given as ${}_b$START$_b$19YY$_b$DDD$_b$HHMMSS$_b$ TO$_b$19YY$_b$DDD$_b$HHMMSS

  where yy is the year, DDD is the Julian Day, and HHMMSS are the hour-minute-and second of the day
- The tape generation date is given in a similar format as GEN$_b$19YY$_b$DDD$_b$HHMMSS

Lines 3, 4, and 5 are used by the subsystem analyst to further identify the origin of the data tape Figure 3-1 is an example of a CRT tape header record

The second file, of each file pair, is the data file and consists of a leading documentation record, a variable number of scan data records, and a trailing documentation record. The leading and trailing documentation records have identical formats and contain 5328 8-bit bytes written in a single block of the same length The scan data records are each 12730 8-bit bytes written in blocks of the same length

```
NIMBUS-7 NOPS SPEC NO T744041 SQ NO ZE2984713 CZCS IPD  TO 22   START 1982 149 195027 TO 1982 149 195227 GEN 1984  59 103321
NIMBUS-7 NOPS SPEC NO T744041 SQ NO ZE2984712 CZCS IPD  TO IPD  START 1982 149 195027 TO 1982 149 195227 GEN 1983 052 045848
CREATED BY MODCOMP IV CIPS VERSION 820921 USING ILT TP NUM  01871 INV NUM UC4473C
```

Figure 3-1   Sample CRT Tape Standard Header Record

3 2 Logical Structure of CRT Tape

The CRT tape data file which follows the NOPS STD HDR file contains up to two minutes (970 scan lines) of CZCS radiance data For most users of these tapes, it will be more convenient to treat the data files as a collection of logical records

As stated previously, the leading and trailing documentation records have identical formats, however, depending on the processing mode, some of the information contained in the leading documentation record may not be valid The documentation record format is illustrated in Figure 3-2 and detailed descriptions of selected data words appear in table 3-1

The scan data records, which appear on the tape between the leading and trailing documentation records, each contain calibration data, earth location data, and 1968 scaled radiances in each of the six CZCS channels for one earth scan of the CZCS instrument The format of the scan data records is illustrated in Figure 3-3 and detailed descriptions of selected data words appear in Table 3-2

Table 3-1

CRT TAPE DOCUMENTATION RECORD

WORD	DESCRIPTION
1	PHYSICAL RECORD NO (12 BITS)–This number is a sequential number beginning at 1 and incrementing by 1 for each physical record within the data files
	SPARES–All spare bits are set to zero
	FILE (2 BITS)–The MSB will be set to "1" to indicate the last record written in a file The LSB will be set to "1" in all records of the last file on the tape
	RECORD I D (6 BITS)–The Record I D for the leading Documentation record will be equal to "1" The record I D in the trailing Documentation record will be "2"
	VALID DATA FLAG (8 BITS)–This flag indicates whether or not certain data fields (designated by an asterisk) contain valid information All bits off (0) indicates the data is invalid and all bits on (1) indicates the data is valid

FILE NO (8 BITS)–This number identifies the file number on the CRT tape

2 TARGET AREA CODE (3 8 BIT WORDS)–Each code will describe a target area which was covered by the data in the file

3 TAPE SEQUENCE NO (32 BITS)–The 32 bit integer representation of the "SEQUENCE NO " field in the STANDARD HEADER records

4 FILM FRAME NO (32 BITS)–This 32 bit integer number is the unique film frame number of the film product corresponding to this archive data file

5 STARTING YEAR NUMBER (16 BITS)–This number is in the form 1978 in binary

6 START TIME IN MILLISECONDS GMT (32 BITS)–This number is in milliseconds of the DAY in GMT

7 INCREMENT IN MILLISECONDS TO END OF DATA (32 BITS)*–The number of milliseconds from the start time of the segment to the last data scan in the segment

8 ORBIT NUMBER (16 BITS)–The Nimbus-7 orbit number for the data in this file, 16-bit binary number

9 GEODETIC LATITUDE "CENTER" (16 BITS)*–The latitudes will be an integer number ranging from 0 at the south pole to (180° x 100) 18000 at the North Pole This will provide a location to 01° The center latitude is defined as being the Nadir sample latitude that occurs 1/2 way between the beginning and end of the frame by time

LONGITUDE CENTER (16 BITS)*–The longitude values will range from 0 at the Greenwich Meridan Eastward to 360° x 100 which provides longitude in 0 01 degrees

10/13 GEODETIC LATITUDES AND LONGITUDES (8 x 16 BITS)*–Frame corner latitudes and longitudes defined as in (9) above

14 ILT FLAGS (8 BITS)–Summary of information available in the CZCS-ILT for this data segment

MSB SUMMARY BIT	'0'	At least one set of data not available
	'1'	All relevant data available

TIME CORRECTIONS	'1'	Available
SOLAR EPHEMERIS	'1'	Available
DATA QUALITY LOSS	'1'	Available
VIP DATA	'1'	Available
SPACECRAFT EPHEMERIS (2 BITS)	'00'	None available
	'01'	Predictive
	'11'	Definitive

PARAMETER PRESENCE CODE (8 BITS)—The 6 CZCS channels correspond to parameters 1-6, respectively A single bit is used to indicate the presence (bit set to '1') or absence (bit set to '0') of data for the corresponding parameter in this data segment The MSB is for channel 1 ranging to bit 6 for channel 6, while the 2 LSB's are spares

NO OF MISSING SCANS (16 BITS)—This 16 bit binary integer is the count of missing scans within the actual data segment The missing scans can be identified by examining the time or the scan sequence number in the scan data records

15/17 NO OF SCANS MISSING CHANNELS 1-6 (6, 16 BIT WORDS)*—The number of scans present in the data file in which the respective channel data should be present but is not These data are 16 bit binary integers

18/19 ALGORITHM I D NUMBERS (8, 8 BIT WORDS)—I D words identify the algorithms for channel 1 through channel 6 calibration and for the geographic location of the data, respectively, and the last word is undefined These are 8 bit binary integer words

20/21 DECOM RUN NO AND DECOM REEL NO (2, 32 BIT WORDS)—On the ARCHIVAL CRTT tapes these words will be zeroed On the USER CRTT tapes these 32 bit binary integer words will be set by IPD to the decommutation run and reel numbers, respectively

22 NO OF HDT SYNC LOSSES (16 BITS)*—This binary integer count states the number of sync losses that occnrred reading the HDT_p tape

NO OF HDT PARITY ERRORS (16 BITS)*–A count of the number of parity errors detected on the HDT$_p$ tape during the 2 minute period covered in this file

23. NO OF WBVT SYNC LOSSES (16 BITS)*–This count states the number of sync losses detected by the pre-processor during generation of the HDT$_p$ tape from the Wide Band Video Tape (WBVT) containing the ZIP format CZCS data

NO OF WBVT BIT SLIP OCCURRENCES (16 BITS)*–This count states the number of bit slip occurrences detected by the pre-processor during generation of the HDT$_p$ tape from the WBVT tape containing the ZIP format CZCS data

24/39 SUB-COMMUTATED HOUSEKEEPING DATA (32 16 BIT WORDS)–Average count values 32 housekeeping words The data is scaled with 8 fractional bits

40 BASE PLATE (BP) TEMPERATURE FLAG (8 BITS)–This flag indicates the source of the Baseplate temperature used in calibrating the infrared channel (6) If all bits are off (0), then the baseplate temperature is a normal preset value If all bits are on (1) then the temperature is obtained from the CZCS-ILT

BASEPLATE TEMPERATURE (16 BITS)–Either a nominal temperature value determined from flight experience or an average value computed from the data values in the time span covered by this file This word is in binary with a fractional part of 7 bits (This item will be zeroed except when the channel 6 calibration algorithm requires it)

175 GAIN (8 BITS)–An integer value of 1, 2, 3, or 4, indicating which CZCS gain setting was used for the scene contained in this file

THRESHOLD (8 BITS)–An integer value of 1 (off) or 2 (on) indicating the status of the CZCS threshold function for the scene contained in this file.

TILT ANGLE (16 BITS)–The tilt angle of CZCS for the scene contained in this file Values range from $-20°$ to $+20°$

Two's complement integer, LSB weight is $1/1000°$

176 SCENE CENTER YEAR (16 BITS)*—The year (4 digits) associated with the geographic center of the scene contained in this file

SCENE CENTER DAY-OF-YEAR (16 BITS)*—The day-of-year (1 to 366) associated with the geographic center of the scene

177 SCENE CENTER MILLISECONDS-OF-DAY (32 BITS)*—The milliseconds-of-day (0 to 86399999) associated with the geographic center of the scene contained in this file

178 SOLAR ELEVATION AT SCENE (16 BITS)*—The solar elevation at the geographic center of the scene contained in this file Values range from - 90° to + 90° Two's complement integer, LSB weight is 1/100°

SOLAR AZIMUTH AT SCENE CENTER (16 BITS)*—The solar azimuth at the geographic center of the scene contained in this file Values range from 0° to 360° Unsigned integer, LSB weight is 1/100°

179/180 SCENE CENTER ROLL, PITCH, YAW (16 BITS each)*—The spacecraft attitude at the geographic center of the scene contained in this file Values range from - 32° to + 32° Two's complement integer, LSB weight is 1/1000°

240/251 SLOPES AND INTERCEPTS (12, 32 BIT WORDS)—Slope and intercept for the conversion of the 8 bit channel data in the scan data records to radiometric units (mw/cm^2-ster-um) for channels 1 through 6, respectively This data is signed and 7 bits whole part and 24 bits fractional In the leading documentation record these are preflight calibration values and in the trailing documentation record these are derived from the active calibration and voltage staircases

252/379 TEMPERATURE CONVERSION TABLE (256, 16 BIT WORDS)—Table of Channel 6 data values in degrees Celsius Each of the 256 positions in this table contains the temperature for the corresponding count of the channel 6 data in the scan data records This data has 8 bits whole part and 8 bits fractional part

WORD #					
1	PHYSICAL RECORD NO. (12)	SPARE (4)	FILE (2)	RECORD ID (6)	VALID DATA FLAG (8)
2	TARGET AREA CODES 3 8-BIT WORDS (24)				FILE NO. (8)
3	TAPE SEQUENCE NO. (32)				
4	FILM FRAME NO. (32)				
5	STARTING YEAR NO. (16)		STARTING DAY NO. (16)		
6	STARTING MILLISECONDS OF DAY (32)				
7	INCREMENT IN MILLISECONDS TO END OF DATA (32)				
8	ORBIT NO. (16)		NO. OF SCANS IN SEGMENT (16)		
9	LATITUDE OF CENTER OF DATA (16)		LONGITUDE OF CENTER OF DATA (16)		
10	LATITUDE AND LONGITUDE OF CORNER (FIRST IN TIME-LEFT OF SCAN) 2 16-BIT WORDS (32)				
11	LAT. AND LONG OF CORNER (FIRST IN TIME-RIGHT OF SCAN) 2 16-BIT WORDS (32)				
12	LAT. AND LONG OF CORNER (LAST IN TIME-LEFT OF SCAN) 2 16-BIT WORDS (32)				
13	LAT. AND LONG OF CORNER (LAST IN TIME-RIGHT OF SCAN) 2 16-BIT WORDS (32)				
14	ILT FLAGS (8)	PARAMETER PRESENCE (8)	NO OF MISSING SCANS-ALL CHANNELS (16)		
15-17	NO. OF MISSING SCANS-CHANNEL 1,2,3,4,5,6 6 16-BIT WORDS (96)				
18	ALGORITHM ID's CHANNELS 1,2,3,4 4 8-BIT WORDS (32)				
19	ALGORITHM ID's CHANNELS 5&6 (16) 2 8-BIT WORDS		ALG ID LOCATION (8)		SPARE (8)
20	DECOM RUN NO. 32-BIT BINARY INTEGER (32)				
21	DECOM REEL NO. 32-BIT BINARY INTEGER (32)				

Figure 3-2 CRT TAPE DOCUMENTATION RECORD

WORD #				
22	NO. OF HDT SYNC LOSSES (16)		NO. OF HDT PARITY ERRORS (16)	
23	NO.OF WBVT SYNC LOSSES (16)		NO. OF WBVT BIT SLIPS (16)	
24 -39	AVERAGE OF SUBCOMMUTATED DATA 32 16-BIT WORDS (512)			
40	SPARE (8)	BP. FLAG (8)	BASEPLATE TEMPERATURE (16)	
41 -174	SPARES (4288)			
175	GAIN (8)	THRESHOLD (8)	TILT ANGLE (16)	
176	SCENE CENTER YEAR (16)		SCENE CENTER DAY-OF-YEAR (16)	
177	SCENE CENTER MILLISECONDS-OF-DAY (32)			
178	SOLAR ELEVATION AT SCENE CENTER (16)		SOLAR AZIMUTH AT SCENE CENTER (16)	
179	SCENE CENTER ROLL (16)		SCENE CENTER PITCH (16)	
180	SCENE CENTER YAW (16)		TOP/BOTTOM TICK LABEL FLAG (8)	LEFT/RIGHT TICK LABEL FLAG (8)
181	TOP LEFT TICK LABEL (16)		TOP RIGHT TICK LABEL (16)	
182	BOTTOM LEFT TICK LABEL (16)		BOTTOM RIGHT TICK LABEL (16)	
183	LEFT TOP TICK LABEL (16)		LEFT BOTTOM TICK LABEL (16)	
184	RIGHT TOP TICK LABEL (16)		RIGHT BOTTOM TICK LABEL (16)	
185	TOP TICK INCREMENT (8)	BOTTOM TICK INCREMENT (8)	LEFT TICK INCREMENT (8)	RIGHT TICK INCREMENT (8)

Figure 3-2 CRT TAPE DOCUMENTATION RECORD (Cont)

WORD #		
186 -198	TOP TICK LOCATION ARRAY 27 16-BIT WORDS	
199	(432)	BOTTOM TICK LOCATION ARRAY
200 -212	27 16-BIT WORDS	(432)
213 -225	LEFT TICK LOCATION ARRAY 27 16-BIT WORDS	
226	(432)	RIGHT TICK LOCATION ARRAY
227 -239	27 16-BIT WORDS	(432)
240	CHANNEL 1 SLOPE (RADIANCE)	(32)
241	CHANNEL 1 INTERCEPT (RADIANCE)	(32)
242 -251	SLOPES, INTERCEPTS FOR CHANNELS 2-6 (RADIANCE) 10 32-BIT WORDS	(320)
252 -379	TEMPERATURE CONVERSION TABLE FOR CHANNEL 6 256 16-BIT WORDS	(4096)
380 -385	SLOPES & INTERCEPTS FOR IMAGE ENHANCEMENT EQUATIONS FOR CHANNELS 1-6 12 16-BIT WORDS	(192)
386 -387	SPARES	(64)
388 -1332	CZCS ILT (TAPE SPEC. 724011) TYPE "A" RECORD	(30240)

1332 32-BIT WORDS

Figure 3-2 CRT TAPE DOCUMENTATION RECORD (Cont)

WORD					
1	PHYSICAL RECORD NO. (12)	SPARE (4)	FILE (2)	RECORD ID (6)	CAL QUAL SUMMARY (8)
2	SCAN SEQUENCE NO. (16)		SPARE (8)		TIME UPDATE FLAG (8)
3	YEAR (16)		DAY NO. (16)		
4	MILLISECONDS OF DAY (32)				
5	SUBCOMMUTED DATA VALUE COUNT (16)		SUBCOM ID (8)		SPARE (8)
6-53	VOLTAGE STAIRCASE COUNTS-6 SETS (1 PER CH) OF 16 STEPS (8 BITS WHOLE, 8 BITS FRACTIONAL) (5036)				
54-56	CALIBRATION LAMP RADIANCE COUNT-6 (1 PER CH) 16-BIT WORDS (96)				
57	BLACKBODY TEMPERATURE COUNT (16)		WBVT BIT SLIP/LOSS OF SYNC SUMMARY (16)		
58	NO. OF HDT SYNC LOSSES (16)		NO. OF HDT PARITY ERRORS (16)		
59	NO. OF WBVT SYNC LOSSES (16)		NO. OF WBVT BIT SLIPS (16)		
60-136	LATITUDES FOR 77 ANCHOR POINTS 77 32-BIT SIGNED INTEGERS (2464)				
137-213	LONGITUDES FOR 77 ANCHOR POINTS 77 32-BIT SIGNED INTEGERS (2464)				
214	PIXEL NO. AT 0 NADIR (16)		CAL QUAL CH 1 (8)		CAL QUAL CH 2 (8)
215	CAL QUAL CHANNELS 3 THROUGH 6 4 8-BIT WORDS (32)				
216-707	CHANNEL 1 RADIANCE COUNTS 1968 UNSIGNED 8-BIT WORDS (15744)				
708-3167	CHANNELS 2 THROUGH 6 RADIANCE COUNTS 5 SETS OF 1968 8-BIT WORDS (78720)				
3168-3195	SPARES (896)				

3195 32-BIT WORDS

Figure 3-3 CRT TAPE SCAN DATA RECORD

Table 3-2

CRT TAPE SCAN DATA RECORD

1 PHYSICAL RECORD NO (12 BITS)–This is the number of this record within a file Starts at 2 and increments by 1's up to a maximum of 971 physical records

FILE/RECORD I D (8 BITS)–Identifies record type and the last record written in a file, and records in the last file on the tape The MSB will be set to "1" if that record is the last one written in the file The second most MSB will be set on all records in the last file on the tape The record type will use the 6 LSB of that byte to identify the type of record being read

1 – LEADING DOCUMENTATION RECORD, 7 = DATA RECORD

2 – TRAILING DOCUMENTATION RECORD

CALIBRATION QUALITY SUMMARY (8 BITS)–The bits are defined as follows

MSB	8 = '1'	Questionable Ephemeris (interpolated or extrapolated over more than minute time interval)
	7 = '1'	Questionable spacecraft attitude (valid values not available - 0° used for all axis)
	6 = '1'	At least one of the expected (power was on) channels not present
	5 = '1'	At least one of the expected channels had active calibration value outside expected range
	4 = '1'	At least one of the expected channels had voltage staircase count outside expected range
	3 = '1'	Undefined

2 SCAN SEQUENCE NO (16 BITS)–A number from 1 to 970 that indicates the scan line number within the 2 minute data period of this file Missing scan lines are accounted for

TIME UPDATE FLAG (8 BITS)–This word indicates the trimester in which the time

update occurred ın the CZCS/ZIP major frame All bıts equal zero ındıcates no update occurred ın thıs scan

3 YEAR NO (16 BITS)–Thıs number ıs ın the form "1978" ın bınary

DAY NO (16 BITS)–The Julıan day number Day 1 = January 1

4 MILLISECONDS OF THE DAY (32 BITS)–The number of mıllıseconds sınce the beginning of the GMT day

5 SUBCOMMUTATED DATA VALUE (16 BITS)–One of the 32 housekeepıng data values that repeat every 32 scan lınes Thıs data wıll be the average of the 8 bıt counts of the four samples located ın the channel #2 posıtıon ın the last mınor frame of each scan lıne There wıll be 8 whole and 8 fractıonal bıts ın the word

SUBCOM I D NO (8 BITS)–The channel number for the subcommutated housekeepıng data value provıded ın thıs record Thıs number should ıncrement by 1's from 0 to 31

6/53 RAW STAIRCASE STEP–VOLTAGE CAL (1536 BITS)–There wıll be one set of 16, 16 bıt words for each of the 6 channels ın step number order, then channel number order Each count value ıs an average of the last two samples of the four data samples Each count value ıs 16 bıts wıth 8 bıts whole and 8 bıts fractıonal parts

54/56 CALIBRATION LAMP RADIANCE COUNTS FOR CHANNELS 1 THRU 5 INCLUSIVE–Thıs data ıs the output of each data channel when vıewıng a calıbratıon lamp and wıll be output ın a 16 bıt word (8 bıts whole part, 8 bıts as the fractıonal part) The data for each channel wıll represent an average of the 4 samples receıved from each channel These values are not valıd except when the SUBCOM ID ıs either 15 or 31

BLACKBODY CALIBRATION COUNT (16 BITS)–Same as above, except a blackbody ıs vıewed ınstead of a lamp The data ıs an average of 4 samples acquıred from the channel 6 posıtıon

57 BLACKBODY TEMPERATURE COUNT (16 BITS)–This value will be output, 8 whole part, 8 fractional, as an average of 4 samples located in the last minor frame (15) in the channel #6 position

60/ 213 ANCHOR POINTS GEODETIC LATITUDES AND LONGITUDES (77, 32 BIT WORDS)– These words give the geographic locations for the 77 data pixels defined in Table 3-3 The geodetic latitudes are given in 77 successive words followed by the corresponding 77 longitudes Each value is a signed 32 bit binary integer with 9 bit whole and 22 bit fractional parts

214/ 215 SAMPLE NUMBER OF ZERO DEGREE NADIR SAMPLE (16 BITS)–This number will consist of 11 bits whole part and 5 bits fractional The number will represent a maximum resolution of 1/32 of 0 04 degrees and is counted from the beginning of the earth scan

CALIBRATION QUALITY CHANNEL 1-6 (6, 8-BIT WORDS)–Calibration quality flags for sensor channels 1-6 Each bit is defined as follows

MSB 8 - 7 = Undefined

6 = '1' Data for channel expected (Power On) but not present

5 - 1 = Undefined

All undefined bits are set to zero

216/ 707 RAW DATA VALUES FOR CHANNEL 1 PIXELS (1968, 8 BIT WORDS)–Each data word is representative of the radiance from observations taken at 0 04 degree intervals from scan angle - 39 36 degrees to + 39 32 degrees The radiance values in mw/cm^2-ster-um can be obtained by using these values in the linear relationship defined by the slopes and intercepts in the documentation records

708/ 3167 RAW DATA VALUES FOR CHANNELS 2-6 PIXELS (5 sets of 1968 8 BIT WORDS)– Same as above for channels 2-6, respectively In addition, for channel 6, the values may be used as indices into the TEMPERATURE CONVERSION TABLE in the documentation record to obtain degrees Celsius

Table 3-3

ANCHOR POINTS

Pixel to Pixel	By increment	#Anchor pts / (#Anchor pts)	Scan angle to Scan angle (deg)
1 to 196	+ 15	14/14	- 39 36 to - 31 56
1968 to 1773	- 15	14/14	+ 39 32 to + 31 52
		28/28	
196 to 316	+ 20	6/20	- 31 56 to - 26 76
1773 to 1653	- 20	6/20	+ 31 52 to + 26 72
		12/40	
316 to 466	+ 25	6/26	- 26 76 to - 20 76
1653 to 1503	- 25	6/26	+ 26 72 to + 20 72
466 to 556	+ 30	3/29	- 20 76 to - 17 16
1503 to 1415	- 30	3/29	+ 20 72 to + 17 12
		6/58	
556 to 626	+ 35	2/31	- 17 16 to - 14 36
1413 to 1343	- 35	2/31	+ 17 12 to + 14 32
		4/62	
626 to 706	+ 40	2/33	- 14 36 to - 11 16
1343 to 1263	- 40	2/33	+ 14 32 to + 11 12
		4/66	
706 to 931	+ 45	5/38	- 11 16 to 2 16
1263 to 1038	- 45	5/38	+ 11 12 to 2 12
		10/76	
931 to 984	+ 53	1/77	- 2 16 to 0 04
1038 to 984	- 54		+ 2 12 to 0 04

*NOTE Pixel numbers listed for positive scan angles are + 1 of actual pixel numbers See Table 2-6 for true pixel numbers

4 DATA AVAILABILITY

All of the data produced for the CZCS program is archived with the National Environmental Satellite Data Information Service of NOAA and is available to any user who wishes to purchase it Requests for CZCS data should be addressed to

NOAA/NESDIS
Satellite Data Services Branch
Room 100, World Weather Building
Washington, D C 20233

When ordering data from NESDIS, the user should specify the CZCS scene times (start and end times) and the scene location (corner latitudes and longitudes) In order to assist users in locating scenes of interest, NESDIS will run a computer search of its data base and provide the user with a listing of all scenes within a user specified geographic area and time frame In addition, NESDIS has catalogs available which may be useful as an aid in data selection One catalog lists all of the archived products, including date, time, orbit number, the coordinates of the four corners of the image, and an estimate of cloud cover Another catalog shows the orbital passes for each day of CZCS operation in monthly increments and shows areas along the orbital tracks for which satisfactory data was acquired and will eventually be processed if not already processed

In addition to NESDIS, there are several other places at which photographic data can be viewed In the United States, there is a partial archive at the Scripps Institute of Oceanography, Visability Laboratory, in San Diego, and a full, geographically cataloged archive at the Satellite Experiment Laboratory of NOAA in Suitland, Maryland European data is archived by the Joint Research Centre of the Commission of European Communities in Ispra, Italy and South African data is archived at the National Research Institute for Oceanology in Stellenbosch, South Africa Questions concerning use of these archives, location of NET members, or location of centers that have computer facilities to analyze CZCS data, should be forwarded to Dr Warren A Hovis, Chairman, Nimbus Experiment Team

APPENDIX A

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=ZMDPI.NSI.FORT                                   (SAMPLE  )

C ------------------------------------------------------------
C - THIS PROGRAM IS DESIGNED TO SHOW HOW ONE MAY READ A CRT   -
C - TAPE ON THE IBM 3081 COMPUTER IN BLDG 1 AT GSFC.          -
C - PROGRAMMER: NICK IASCONE 1984 07 20                       -
C ------------------------------------------------------------
C
C ------------------------------------------------------------
C - ITEMS USED TO READ THE PROPER TAPE.                       -
C -                                                           -
      REAL * 8 DDNAME, INTAPE
      INTEGER * 4 SCENE
      COMMON /BLOCK1/ SCENE
      NAMELIST /PARM1/ SCENE, INTAPE
      DATA DDNAME /'CRTTAPE '/
C -                                                           -
C ------------------------------------------------------------
C
C --- FIND OUT THE TAPE NAME AND SCENE ---
      PRINT 10
      READ ( 5, PARM1 )
      PRINT 20, SCENE, INTAPE
C
C --- CONVERT THE DESIRED SCENE TO FILES ---
      IFILE1 = 2*SCENE - 1
      IFILE2 = IFILE1 + 1
C
C --- MOUNT THE DESIRED TAPE ---
      IO = 1
      CALL MOUNT ( IO, DDNAME, INTAPE )
C
C --- READ THE STANDARD HEADER RECORDS FROM THE FIRST FILE ---
      CALL REDHED ( IFILE1, IERR )
      IF ( IERR .NE. 0 ) STOP
C
C --- MOVE TO NEXT FILE TO CONTINUE PROCESSING ---
      CALL POSN ( IO, DDNAME, IFILE2 )
C --- PROCESS SECOND FILE ---
      CALL CRTSCN ( IERR )
C
      STOP
C
   10 FORMAT ( 1X, 'START OF CRT TAPE READ PROGRAM' )
   20 FORMAT ( / 1X, 'SCENE ', I2, ' FROM TAPE ', A8, ' REQUESTED.'/ )
      END
      SUBROUTINE REDHED ( IFILE, IERR )
C ---------------------------------------------------------
C - SUBROUTINE REDHED READS AND SAVES THE STANDARD HEADER  -
C - RECORDS FROM THE CRT TAPE.                             -
C - PROGRAMMER: NICK IASCONE 1984 07 20                    -
C ---------------------------------------------------------
C
C ---------------------------------------------------------
C - ITEMS FOR STANDARD HEADER RECORD INPUT AND STORAGE.    -
C -                                                        -
      LOGICAL * 1 HDR1(630), HDR2(630)
      COMMON /BLOCK2/ HDR1, HDR2
```

```
C -                                                          -
C ------------------------------------------------------------
C ------------------------------------------------------------
C - TAPE PROCESSING RELATED ITEMS.                           -
C -                                                          -
      REAL * 8 DDNAME
      DATA DDNAME /'CRTTAPE '/
      INTEGER * 4 IFILE1, IERR
C -                                                          -
C ------------------------------------------------------------
C
      IERR = 0
C --- POSITION TO FIRST FILE ---
      IO = 1
      CALL POSN ( IO, DDNAME, IFILE1 )
C --- READ FIRST STANDARD HEADER RECORD ---
      LC = 0
      IREAD = 1
      CALL FREAD ( HDR1, DDNAME, LENGTH, LC, &10, &20 )
      IF ( LENGTH .NE. 630 ) IERR = 21
      IF ( LENGTH .NE. 630 ) PRINT 30, IREAD, LENGTH, IERR
      IF ( LENGTH .NE. 630 ) RETURN
      PRINT 40, IREAD, ( HDR1( J ), J = 1, 630 )
C
      IREAD = 2
      CALL FREAD ( HDR2, DDNAME, LENGTH, LC, &10, &20 )
      IF ( LENGTH .NE. 630 ) IERR = 22
      IF ( LENGTH .NE. 630 ) PRINT 30, IREAD, LENGTH, IERR
      PRINT 40, IREAD, ( HDR1( J ), J = 1, 630 )
      RETURN
C
C --- THIS SECTION OF CODE IS REACHED WHEN EOF ENCOUNTERED ---
   10 IERR = 23
      PRINT 50, IREAD, IERR
      RETURN
C
C --- THIS SECTION OF CODE IS REACHED WHEN I/O ERROR ENCOUNTERED ---
   20 IERR = 24
      PRINT 60, IREAD, LENGTH, IERR
      RETURN
C
C
   30 FORMAT ( / 1X, 'STANDARD HEADER RECORD ', I1, ' HAD LENGTH = ', I6
     1/ 1X, 'WHICH WILL RESULT IN IERR = ', I3, ' AND SUBROUTINE RETURN.
     2'/ )
   40 FORMAT ( / 1X, 'STANDARD HEADER RECORD ', I1, ' ='/ 5( / 1X, 126A1
     1)/ )
   50 FORMAT ( / 1X, 'EOF ENCOUNTERED INSTEAD OF STANDARD HEADER ', I1/
     11X, 'IERR WILL BE SET TO ', I3, ' AND REDHED WILL RETURN.'/ )
   60 FORMAT ( / 1X, 'I/O ERROR ENCOUNTERED FOR STANDARD HEADER ', I1/ 1
     1X, 'LENGTH OF RECORD WAS ', I6/ 1X, 'IERR WILL BE SET TO ', I3, '
     2AND REDHED WILL RETURN' )
      END
      SUBROUTINE CRTSCN ( IERR )
C ------------------------------------------------------------
C - SUBROUTINE CRTSCN READS THE DATA FILE OF THE CRT TAPE.-
C - IT SAVES THE 2 DOCUMENTATION RECORDS, WHICH ARE THE    -
C - FIRST AND LAST RECORDS IN THE DATA FILE, FOR LATER     -
C - USE.                                                   -
C - PROGRAMMER: NICK IASCONE 1984 07 20                    -
```

```
C ----------------------------------------------------------
C
C ----------------------------------------------------------
C - INPUT ARRAYS                                           -
C -                                                        -
      LOGICAL * 1 CRTDRL(5328), CRTDRT(5328)
      LOGICAL * 1 INBUFF(12780)
      COMMON /BLOCK3/ CRTDRL, CRTDRT
      COMMON /BLOCK4/ INBUFF
C -                                                        -
C ----------------------------------------------------------
C
C ----------------------------------------------------------
C - ITEMS RELATED TO PROCESSING                            -
C -                                                        -
      INTEGER * 4 GETRID, RECID, IERR
      LOGICAL * 4 FIRST
      INTEGER * 4 I4DUMB
      EQUIVALENCE(INBUFF(1) , I4DUMB)
C -                                                        -
C ----------------------------------------------------------
C
C ----------------------------------------------------------
C -                                                        -
      REAL * 8 DDNAME
      DATA DDNAME /'CRTTAPE '/
C -                                                        -
C ----------------------------------------------------------
C
      FIRST = .TRUE.
      IERR = 0
      IREC = 0
C --- READ A RECORD ---
      LC = 0
   10 CALL FREAD ( INBUFF, DDNAME, LENGTH, LC, &40, &50 )
      IREC = IREC + 1
      PRINT 60, IREC
      IF ( .NOT.FIRST ) GO TO 20
C --- TO GET HERE, THIS MUST BE FIRST RECORD AND IT HAD ---
C --- BETTER BE A DOCUMENTATION RECORD.                 ---
      RECID = GETRID( I4DUMB )
      IF ( LENGTH .NE. 5328 ) IERR = 31
      IF ( LENGTH .NE. 5328 ) PRINT 70, LENGTH, IERR
      IF ( LENGTH .NE. 5328 ) RETURN
C
      IF ( RECID .NE. 1 ) IERR = 32
      IF ( RECID .NE. 1 ) PRINT 80, IERR, RECID
      IF ( RECID .NE. 1 ) RETURN
C
C --- SAVE THE FIRST DOC RECORD IN CRTDRL ---
      CALL EQUIVL ( IREC )
      PRINT 90
      FIRST = .FALSE.
      GO TO 10
C
   20 RECID = GETRID( I4DUMB )
      IF ( RECID .NE. 2 ) GO TO 30
C --- TO GET HERE, RECORD SHOULD BE DOC RECORD 2 ---
      IF ( LENGTH .NE. 5328 ) IERR = 33
      IF ( LENGTH .NE. 5328 ) PRINT 100, IREC, LENGTH, IERR
```

```
      IF ( LENGTH .NE. 5328 ) RETURN
C --- TO GET HERE, WE SHOULD HAVE GOOD TRAILING DOC RECORD ---
C --- TRAILING DOC RECORD WILL BE STORED IN CRTDRT         ---
      CALL EQUIVL ( IREC )
      PRINT 110, IREC
      RETURN
C
C
C --- TO GET HERE, WE SHOULD HAVE A DATA RECORD ---
   30 IF ( RECID .NE. 7 ) IERR = 34
      IF ( RECID .NE. 7 ) PRINT 120, IREC, LENGTH, RECID, IERR
      IF ( RECID .NE. 7 ) RETURN
C
C --- TO GET HERE WE SHOULD HAVE A GOOD DATA RECORD ---
C
      GO TO 10
C
C --- TO GET HERE, AN EOF WAS ENCOUNTERED ---
   40 IERR = 35
      PRINT 130, IREC, IERR
      RETURN
C
C --- TO GET HERE, AN I/O ERROR WAS ENCOUNTERED ---
   50 IERR = 36
      PRINT 140, IREC, LENGTH, IERR
      RETURN
C
   60 FORMAT ( 1X, 'SUCCESSFULL READ OF RECORD ', I4 )
   70 FORMAT ( / 1X, 'FIRST DOC RECORD HAD LENGTH = ', I6/ 1X, 'IERR WIL
     1L BE SET TO ', I3, ' AND CRTSCN WILL RETURN.'/ )
   80 FORMAT ( / 1X, 'IERR WILL BE SET TO ', I3, ' BECAUSE DOC RECORD HA
     1D RECORD HAD ID = ', I3, '. CRTSCN WILL THEN RETURN.'/ )
   90 FORMAT ( 1X, 'FIRST DOC RECORD SAVED.' )
  100 FORMAT ( / 1X, 'RECORD ', I4, ' HAD A LENGTH OF ', I6, '.'/ 1X, 'I
     1T HAD A RECID OF ', I3, '.'/ 1X, 'IERR WILL BE SET TO 33 AND CRTSC
     2N WILL RETURN.'/ )
  110 FORMAT ( / 1X, 'RECORD ', I3, ' WAS TRAILING DOC RECORD.'/ )
  120 FORMAT ( / 1X, 'RECORD ', I4, ' HAD LENGTH OF ', I6, ' AND ID = ',
     1I3/ 1X, 'IERR WILL BE SET TO ', I3, ' AND CRTSCN WILL RETURN.'/ )
  130 FORMAT ( / 1X, 'EOF ENCOUNTERED FOR RECORD ', I4, ' . IERR SET TO
     1', I3/ )
  140 FORMAT ( / 1X, 'RECORD ', I4, ' WITH LENGTH OF ', I6, ' HAD I/O ER
     1ROR.'/ 1X, 'IERR SET TO ', I3/ )
      END
      INTEGER FUNCTION GETRID*4 (I4VAL)
C ----------------------------------------------------------------
C - FUNCTION GETRID CONVERTS THE INPUT VALUE I4DUMB INTO A       -
C - RECORD ID. GETRID = 1 CORRESPONDS TO A DOCUMENTATION         -
C - RECORD AND GETRID = 7 CORRESPONDS TO A DATA RECORD.          -
C - PROGRAMMER: NICK IASCONE 1984 07 20                          -
C ----------------------------------------------------------------
C
      INTEGER * 4 I4DUMB, I4VAL
      INTEGER * 2 I2TEST
      LOGICAL * 1 L1TEST(2), L1DUMB(4)
      EQUIVALENCE(I2TEST, L1TEST(1))
      EQUIVALENCE(I4DUMB, L1DUMB(1))
C
      I4DUMB = I4VAL
      I2TEST = 0
```

```
      L1TEST( 2 ) = L1DUMB( 3 )
      IF ( I2TEST .GE. 128 ) I2TEST = I2TEST - 128
      IF ( I2TEST .GE. 64 ) I2TEST = I2TEST - 64
C
      GETRID = I2TEST
C
      RETURN
C
      END
      SUBROUTINE EQUIVL ( IREC )
C -------------------------------------------------------------
C - SUBROUTINE EQUIVL ASSIGNS THE FIRST 5328 BYTES OF INBUFF -
C - TO THE INDICATED DOCUMENTATION RECORD ARRAY.             -
C - PROGRAMMER: NICK IASCONE 1984 07 20                      -
C -------------------------------------------------------------
C
      LOGICAL * 1 CRTDRL(5328), CRTDRT(5328)
      COMMON /BLOCK3/ CRTDRL, CRTDRT
      LOGICAL * 1 INBUFF(12780)
      COMMON /BLOCK4/ INBUFF
C
      IF ( IREC .NE. 1 ) GO TO 20
C --- IREC = 1 INDICATES THIS IS FIRST DOC RECORD ---
      DO 10 I = 1, 5328
        CRTDRL( I ) = INBUFF( I )
   10 CONTINUE
C
      RETURN
C
C --- IREC .NE. 1 INDICATES THIS IS NOT THE FIRST RECORD, ---
C --- THEREFORE THIS IS NOT THE FIRST DOCUMENTATION RECORD ---
   20 CONTINUE
      DO 30 I = 1, 5328
        CRTDRT( I ) = INBUFF( I )
   30 CONTINUE
C
      RETURN
      END
```

```
//ZMDPISAM JOB (C0007,SAS,3),CRT-READ,TIME=(,15),
//   CLASS=A,MSGCLASS=A,NOTIFY=ZMDPI,MSGLEVEL=(1,1)
/*JOBPARM QUEUE=FETCH
//STEP1 EXEC OFORTH,PARM='OPT=2,XREF,ID',OUT=A
//SOURCE.SYSIN DD DSN=ZMDPI.NSI.FORT(SAMPLE),DISP=SHR
//STEP2 EXEC OLINKGOH,REGION.GO=250K,OUT=A,TERMOUT=A,BLKSIZE=141
//SYSPRINT DD SYSOUT=A
//GO.FT05F001 DD *
 &PARM1 SCENE=1,INTAPE='DPI02  ', &END
//GO.FT06F001 DD SYSOUT=A
//GO.CRTTAPE DD UNIT=(6250,,DEFER),LABEL=(1,NL,,IN),
// DCB=(RECFM=U,BLKSIZE=12780,DEN=3),
// VOL=SER=PHLEGM,DISP=SHR
//GO.SYSUDUMP DD SYSOUT=A
//NOTE EXEC NOTIFYTS

*** END OF MEMBER ***     15 RECORDS PROCESSED   ********************************
```

APPENDIX B

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16 Abstract

The CZCS is a scanning multispectral radiometer designed specifically for the remote sensing of Ocean Color parameters from an earth orbiting space platform.

This Technical Manual is intended for users of NIMBUS 7 CZCS Level 1 data products. It contains information needed by Investigators and Data Processing personnel in order to operate on the data using digital computers and related equipment.

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